ABSTRACT OR SUPPORTING INFORMATION

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Evaluation of Cabin Crew Technical Knowledge

Accident and incident reports have indicated that flight attendants have numerous opportunities to provide the flight-deck crew with operational information that may prevent or lessen the severity of a potential problem. Additionally, as carrier fleets transition from three person to two person flight-deck crews, the reliance upon the cabin crew for the transfer of this information may increase further. Recent research (Chute & Wiener, 1996) indicates that flight attendants do not feel confident in their ability to describe mechanical parts or malfunctions of the aircraft, and the lack of flight attendant technical training has been referenced in a number of recent reports (National Transportation Safety Board, 1992; Transportation Safety Board of Canada, 1995; Chute & Wiener, 1996).

The present study explored both flight attendant technical knowledge and flight attendant and pilot expectations of flight attendant technical knowledge. To assess the technical knowledge of cabin crewmembers, 177 current flight attendants from two U. S. carriers voluntarily completed a 13-item technical quiz. To investigate expectations of flight attendant technical knowledge, 181 pilots and a second sample of 96 flight attendants, from the same two airlines, completed surveys designed to capture each group's expectations of operational knowledge required of flight attendants.

Analyses revealed several discrepancies between the present level of flight attendant operational knowledge and pilots' and flight attendants' expected and desired levels of technical knowledge. Implications for training will be discussed.

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Accident and incident reports have indicated that flight attendants have numerous opportunities to provide the flight-deck crew with operational information that may prevent or lessen the severity of a potential problem. Additionally, as carrier fleets transition from three to two person flight-deck crews, the reliance upon the cabin crew for the transfer of such information may increase further. Recent research indicates that flight attendants do not feel confident in their ability to describe mechanical parts or malfunctions of the aircraft. Additionally, this lack of flight attendant technical training has been referenced in a number of recent reports. The present study explored both flight attendant technical knowledge and flight attendant and pilot expectations of flight attendant technical knowledge. Results suggest that cabin crews are not receiving the amount of technical training that both pilots and cabin crew members believe is necessary for the efficient exchange of safety information. Implications for training are discussed.

Evaluation of Cabin Crew Technical Knowledge

On July 19, 1989, a United Airlines DC-10 experienced an uncontained failure of the number two engine during cruise flight which resulted in the loss of all the aircraft's hydraulic systems. Thereafter, the aircraft was flown by manipulation of the power controls for the two engines that remained functional. During this time, a flight attendant reported to the flight crew that there was damage to the "back wing" (National Transportation Safety Board, 1989). The second officer proceeded to the cabin and looked at the wings, but the damage was actually to the horizontal stabilizer rather than a wing. While in this example of the Sioux City accident, there was sufficient time and personnel available to assess the accuracy of the flight attendant's report, the implications of an inadequate command of aircraft terminology and mechanical knowledge by flight attendants are potentially serious (National Transportation Safety Board, 1989).

The 1989 Kegworth accident provides an example of what can result under circumstances where the cabin crew might have provided critical information which the flight-deck crew could not have gathered themselves. Leading to the Kegworth crash, a British Midlands Boeing 737-400 experienced an engine fire about 13 minutes after taking off from Heathrow Airport. The pilots reduced power to the right engine, which diminished the vibration in the aircraft, and led them to the conclusion that the problem was with the right engine. The flight-deck crew then proceeded to shutdown the right engine. While this decision making was taking place in the cockpit, flight attendants and passengers could see flames shooting from the left engine. Yet even after a flight-deck announcement to the passengers that there had been trouble with the right engine, which had now been shut down, none of the flight attendants reported the discrepancy or their concerns to the cockpit.

Recently, several factors have emerged which compel a closer examination of the interface between the cabin and cockpit crews, and the facilitation of the transfer of technical information specifically. First, automation has led to the proliferation of 2-pilot aircraft. As the position of the flight engineer has been replaced by advanced technology, the flight crew has also lost the trained eyes and ears of an intermediary to information beyond the cockpit door. Responsibility for detecting anomalies in proximity to the cabin which are outside the capabilities of the automated systems and for accurately relaying that information to the pilots now falls to the cabin crew.

Second, flight attendants have not been trained to be technically aware nor articulate in order to facilitate effective information transfer. Chute and Wiener (1996) report that when flight attendants were asked to describe their confidence in their ability to describe mechanical parts or malfunctions of the aircraft, almost 60% responded "moderately" or less. These results are not surprising when one considers that the FAA flight attendant initial and transition ground training requirements (FAR 121.421) only specify that the flight attendant be aware of the physical characteristics of the aircraft that may have a bearing on responsibilities such as ditching, evacuation, and inflight emergency procedures and on other related duties. Examples of the required topics are: The use of the public address system, electrical galley equipment, and the controls for cabin heat and ventilation. Presently, most training curricula incorporate only these topics.

And third, research has shown that effective communication between the cockpit and cabin is hampered by barriers which exist between the two crews (Chute & Wiener, 1995). Not only are the flight attendants nonconversant in technical knowledge, but their input is not cultivated as a source of information.

The lack of flight attendant technical training has been referenced in a number of recent reports (National Transportation Safety Board, 1992; Transportation Safety Board of Canada, 1995; Chute & Wiener, 1996). As we saw with the Sioux City accident, valuable time could be lost if information is not conveyed in a timely and accurate manner. Conversely, if the cabin crews have a working knowledge of aircraft systems and terminology, information transfer can be facilitated.

The purpose of this study was to measure the technical knowledge currently possessed by cabin crew members, as well as to explore the level of technical knowledge both flight-deck and cabin crew members expect flight attendants to maintain.

Method

Participants

In order to examine technical knowledge, flight attendants from two United States airlines voluntarily completed questionnaires. These participants included 122 female and 55 male current flight attendants ranging in age from 22 to 75 (M=39, SD=8.40). The average number of years as a flight attendant was 12 (SD=8.49). Ninety-one percent of the flight attendants had some college experience and 41% were college graduates. The average number of months since their last recurrent training class was five (SD=3.81). Only 16% of the flight attendants had any kind of pilot instruction and only three had their private pilot license.

To investigate expectations of flight attendant technical knowledge, pilots and a second sample of flight attendants from the same two airlines completed a second set of surveys. Flight attendant volunteers included 78 females and 18 males, with the average age of the participants being 39 years (SD=8.40), ranging from 25 to 64 years of age. The mean number of years as a flight attendant was 14.09 (SD=8.35). Eighteen percent of the flight attendant volunteers for this survey had some piloting experience, which ranged from ground school to a private pilot license. One hundred eighty-one pilots participated in the study. All but one of the pilots were male. One hundred six volunteers were captains, 56 were first officers, and 19 were second officers. The average number of years as a pilot was 18.96 (SD=8.61) and the mean age of the pilot group was 48 years (SD=7.65), ranging from 32 to 73 years.

Materials

Flight attendant technical knowledge was measured using a 13-item questionnaire consisting of questions addressing basic aerodynamics, aircraft systems and components, and procedural issues. Both cockpit and cabin crew members' expectations of flight attendant operational knowledge were assessed using a 13-item survey consisting of a series of ten skill areas and three short fill-in questions. Volunteers were asked to rate each skill area, on a five-point scale, as to their expectation about how knowledgeable a flight attendant would be in the given area. Confidentiality of the participants was guaranteed through the anonymity of the questionnaires.

Procedure

Technical questionnaire. Upon the approval of both flight attendant union and management, flight attendants were recruited from their company briefing area and asked to volunteer 15 minutes of their time to complete the technical questionnaire. Flight attendants who chose to participate in the study were then given written instructions and a copy of the questionnaire. Participants completed the questionnaire and returned it directly to the researcher.

Flight attendant and pilot expectation survey. Survey packets were randomly distributed to a sample of flight attendants and pilots in their company mailbox. Each packet consisted of an informed consent letter, a copy of the survey, and a stamped, addressed return envelope. Participants completed the survey and returned it directly to the researcher in the envelope that was provided. Flight attendant volunteers who completed the technical questionnaire were asked not to participate in the training topics survey. A total of 600 surveys were distributed to each group, with a 30% return rate for pilots and 16% for flight attendants.

Results and Discussion

Because the potential differences between the two airlines were beyond the scope of this study and the use of two airlines was intended solely to increase the sample size, all data were collapsed across airlines. The study consisted of two main parts, flight attendant technical knowledge and flight attendant and pilot expectations of flight attendant technical knowledge. Analyses were performed on the data from each of these groups and are presented below.

Technical questionnaire

The technical survey included ten multiple choice items examining flight attendants' knowledge of aircraft systems and procedures and a question on the theory of flight. Frequencies of correct answers were calculated for each question and the results are provided in Figure 1.

Sterile cockpit. Analyses of the technical survey revealed several areas where flight attendant training programs may be inadequate. One of the most important issues is that of the "sterile cockpit." Chute and Wiener (1996) have addressed concerns about the application of sterile cockpit regulations to the cabin and of the confusion cabin crew members seem to have in the interpretation of the regulation. The FAA regulation of "sterile cockpit" states that no flight crew member shall perform any duties during a critical phase of flight except those duties required for the safe operation of the aircraft, and furthermore, that no flight crew member may engage in any activity during a critical phase of flight which could distract a crew member or interfere in any way with the proper conduct of the flight (FAR 121.542). Recent research (Chute, 1994) describes the hesitancy of cabin crew members to interrupt sterile cockpit and the need for clarification of this regulation. The present study confirmed that the understanding of sterile cockpit rules remains unclear. When given the scenario, "You are sitting at an exit door. One minute after takeoff you hear an UNUSUAL whistling sound that appears to be located near the door. As lead flight attendant what action would you take?" only 50% of the subjects would call the flight deck immediately and 3% either would not call at all or did not know what to do. Less than half of the volunteer flight attendants stated that they would pass forward information about the exit door's unusual whistling sound, regardless of sterile cockpit. This result is of particular significance since a similar situation, on an ATR 72, resulted in the separation of the rear cabin door during takeoff, at approximately 800 feet AGL (National Transportation Safety Board, 1995a). The lead flight attendant reported hearing a very loud humming noise coming from the door after takeoff and that the noise was unlike anything she had ever heard in the past. However; she did not use the interphone to contact either the #2 flight attendant or the cockpit crew regarding the noise. In an interview with an NTSB investigator, when asked under what conditions would she consider calling the cockpit during the sterile cockpit phase, the flight attendant responded that she, "Would call the cockpit if there was an emergency such as a fire or a problem passenger (National Transportation Safety Board, 1995b)". Responses to the sterile cockpit question indicate that the sterile cockpit regulation continues to be a point of confusion for flight attendants regarding appropriate reasons for the interruption of the sterile cockpit.

Fire detection. Smoke detection is another important area where knowledge can prevent or lessen a dangerous situation. An understanding of smoke and fire detection could be helpful in identifying the source of a fire and in leading to a more expeditious solution. Additionally, knowledge of characteristics of types of smoke may help the cabin crew communicate reports of smoke or fire to the flightdeck more clearly and effectively. Flight attendants who participated in the technical survey were not aware that there are differences between the look and smell of smoke from an electrical system fire versus that of the smoke from a heating/cooling system fire. Twenty percent of the flight attendants did not think there was any difference between the two types of smoke and 24% answered that they did not know whether there was a difference or not.

APU torching. Torching on auxiliary power unit (APU) start up was also addressed. Only 52% of the participants were aware that this is a common occurrence on some aircraft types, and is a self-contained engine fire and is not a problem. There have been numerous Aviation Safety Reporting System (ASRS) reports of passenger-initiated evacuations that were the result of passengers seeing a sudden flash of fire during APU start up. Familiarity with the APU may provide flight attendants with the knowledge to relieve the concerns of passengers and deter ensuing unnecessary evacuations. Eight percent believed that torching on APU start up was an emergency situation and approximately 19% could not answer the question.

Theory of flight. The question regarding the theory of flight proved to be one of the most difficult. Only 29% of participating flight attendants knew that the four counterbalancing forces are lift, weight, thrust, and drag.

Aircraft Systems and Procedures. When examining flight attendants' knowledge of aircraft systems and procedures, over 86% of participants knew that the hydraulic system provides the power (force) needed to move the ailerons, elevators, and rudders of the large aircraft. Eighty-two percent were aware that snow build-up, as well as icing, can be a problem. Another question assessed whether the flight attendants know where fire detection systems may be located. Only 72% of the participants knew that fire detection systems can be located in the engines, cargo compartment, as well as the main gear wheel wells and 16.4% did not know of any location.

Aircraft components. Still another area of flight attendant technical training which falls short is that of knowledge of the aircraft itself. Only 11% of the flight attendants were able to correctly match the labels of eight basic aircraft components on a diagram. These components included such parts as the vertical and horizontal stabilizers, the trailing-edge flaps, the spoilers, and the rudder. A breakdown of responses for each component is shown in Figure 2. Additionally, 83% of participants did not know that aircraft engines are numbered from left to right. Ninety-five percent of the flight attendants correctly labeled the right and left sides of the aircraft, which can be a point of confusion as flight attendant duties and jumpseats often require them to face the opposite direction of reference. A basic knowledge of these aircraft parts can not only help the cabin crew more clearly describe concerns to the flight deck, but may also help flight attendants understand information that they receive from the flightdeck.

Overall Scores. Percentage of total correct responses was calculated to determine an overall score on the technical questionnaire (M=61%, SD=16%). To examine whether number of years as a flight attendant and number of months since last recurrent training class influence the overall score, Pearson correlation coefficients were calculated. Results indicated no significant relationship between overall score on the technical questionnaire and time as a flight attendant, and overall score and time since recurrent training ($r = .15$, $p = .06$; $r = -.03$, $p = .70$, respectively).

Previous piloting experience is another variable which could have influenced the overall score on the technical questionnaire. As noted earlier, 16% of flight attendant participants had some previous piloting experience. In order to assess the influence of this variable, a two (pilot experience) by thirteen (subject area) mixed design analysis of variance (ANOVA) was conducted on scores on the technical questionnaire. Pilot experience was a between subjects factor. Results revealed a subject area by pilot experience interaction ($F_{(12,2100)} = 17.86$, $p < .001$). The pattern of the means indicates that flight attendants who had some piloting experience scored better in some subject areas than did those flight attendants without piloting experience.

In order to examine the interaction further, several one-way ANOVAs were conducted. Results of the analyses revealed a significant difference between flight attendants with piloting experience and those without, in the areas of basic aerodynamics ($F_{(1,175)} = 13.89$, $p < .001$), fire detection systems ($F_{(1,175)} = 5.13$, $p < .05$), and labeling of aircraft components ($F_{(1,175)} = 15.52$, $p < .001$). As shown in Figure 3, the pattern of means illustrate that for each of these three items, flight attendants with piloting experience scored higher than those without piloting experience.

Expectations of Flight Attendant Technical Knowledge

Ratings of knowledge expectation. Pilots and a different sample of flight attendants were asked to rate, on a five-point scale (1=not at all knowledgeable to 5=very knowledgeable), a series of operational skill areas according to their expectation that a flight attendant would be knowledgeable in that given area. Expectations of flight attendant knowledge varied across topics. Both pilots and flight attendants expected flight attendant knowledge to be highest regarding safety procedures and sterile cockpit rules and lowest in the more technical areas of basic aerodynamics and function of aircraft components.

A two (job position) by ten (skill area) mixed design analysis of variance (ANOVA) was conducted on expectations of flight attendant technical knowledge. Results revealed a skill area by position interaction ($F(9,2430) = 9.63$, $p < .001$). The pattern of the means, presented in Figure 4, indicates that pilots and flight attendants had similar expectations for many skill areas, but different expectations for others.

In order to examine the interaction further, several one-way ANOVAs were conducted. Results of the analyses revealed a significant difference between pilot and flight attendant expectations of flight attendant knowledge in the areas of basic aerodynamics ($F(1,275) = 11.91$, $p < .01$), aircraft systems ($F(1,275) = 10.80$, $p < .01$), sterile cockpit ($F(1,275) = 22.28$, $p < .01$), and crew resource management (CRM) ($F(1,273) = 12.37$, $p < .01$), with flight attendants having higher expectations of knowledge than pilots in all cases except CRM.

Need for flight attendant technical knowledge. Pilot and flight attendant volunteers were asked to list 5 subject areas that they thought should be part of flight attendant training. The five most frequently given responses to this question are shown in Figure 5. Thirty-seven percent of pilots and 40% of flight attendants included flight attendant technical training as one of the five most important training needs. Additionally, pilots and flight attendants stated that they do not believe that flight attendants are receiving the amount of technical knowledge necessary for the efficient exchange of safety information. Sixty-seven percent of pilots and 59% of flight attendants found this type of training lacking. One pilot summed up his thoughts with, "When a flight attendant tells me that the "thingy" on the "whatsit" is loose, I know there's not enough technical training," and a flight attendant concurred, "The only time we learn about mechanical problems on the aircraft is when they occur. We should have at least one day of training to include information on turbulence, theory of flight, and basic operations of the aircraft." Both incidents and accidents demonstrate that cabin crew members have numerous opportunities to provide valuable safety information to the flightdeck. In the present survey, 62% of pilots responded that they have received important safety information concerning the aircraft (aside from cabin equipment), from a flight attendant and 69% of the flight attendants reported providing the flight-deck crew with that safety information. For example, one pilot reported, "A flight attendant came to the flightdeck to pass on information that an engine was loose and hanging from the wing. We were not aware because all indications were normal." Another reported, "In Moscow - taxiing for takeoff to New York. Maximum gross takeoff weight. A flight attendant called us while taxiing and reported a popping noise 'under the aircraft at the wings.' It was a blown tire. We (pilots) had no idea it was blown."

Conclusions

The present study reports several important findings. First, the results indicate that flight attendants do not evidence a great deal of technical knowledge in the areas sampled by the technical survey. Despite this result, the responses to the open-ended questions on the second instrument indicated that there are many instances where flight attendants have the potential to provide technical information to the flight-deck crew. Second, both flight attendant and pilot expectations of flight attendant technical knowledge overall were low, with only half of the topic areas receiving a rating of 3.5 or better. Third, flight attendant technical knowledge does not appear to be acquired while on the line.

Regarding pilot and flight attendant expectations, it may be that since flight attendant training curricula rarely include the technical issues studied here, the low expectations described above may reflect the level of knowledge to which pilots and flight attendants have become accustomed. This conclusion is also indicated by the fact that some of the specific skill areas, such as basic aerodynamics and sterile cockpit, where flight attendants had difficulty on the technical survey, were also areas in which pilots expected even less knowledge than did flight attendants. These low expectations may have an impact on the communication process. If the pilots do not expect reliable information from the flight attendants, they may be more skeptical about the information they do receive and more hesitant to utilize cabin crew members as a source of information. Likewise, if flight attendants are not comfortable with their flying partners' technical knowledge, or even their own, they may be less willing to pass information forward to the flight-deck crew.

Finally, the results of the study also suggest that flight attendants are not picking up this technical knowledge while on the line, evidenced by the fact that overall knowledge was not significantly related to number of years as a flight attendant. Both initial and recurrent flight attendant training could promote a better understanding of aerodynamics, aircraft systems, and basic components of the aircraft, so the knowledge is maintained over time and new issues addressed. Providing a common technical language for the cabin and cockpit crews is only a starting point. Given the continuing confusion over the sterile cockpit regulation, an emphasis must be made in training as to the importance of passing information up to the cockpit to let the pilots decide its relevance or importance. If the information never gets passed between the crews, it is of little value. Recently, the FAA ruled on a new training requirement for flight attendants under part 121 and part 135 operations (Federal Aviation Administration, 1996). The regulation requires both initial and recurrent flight attendant training curriculum to include crew resource management (CRM) training. This new curriculum ruling can be a good opportunity for airlines to address technical issues.

In addition to CRM training, jumpseat experience would give flight attendants an idea of the types of information to which the pilots do not have access, as well as demonstrating standard flight operations and pilot workload. While some airlines have begun to allow cockpit jumpseat or simulator rides for flight attendants, this practice could be expanded.

While no one expects flight attendants to attain the level of technical knowledge that pilots possess, improvements can be made to raise the current level of flight attendant technical knowledge in order for cabin and cockpit crew members to be able to communicate safety information more clearly, quickly, and effectively. Finally, future research should examine further the complex elements of inter-group processes in effective communication within the context of airline operations and their implications for flight safety.

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Figure Captions

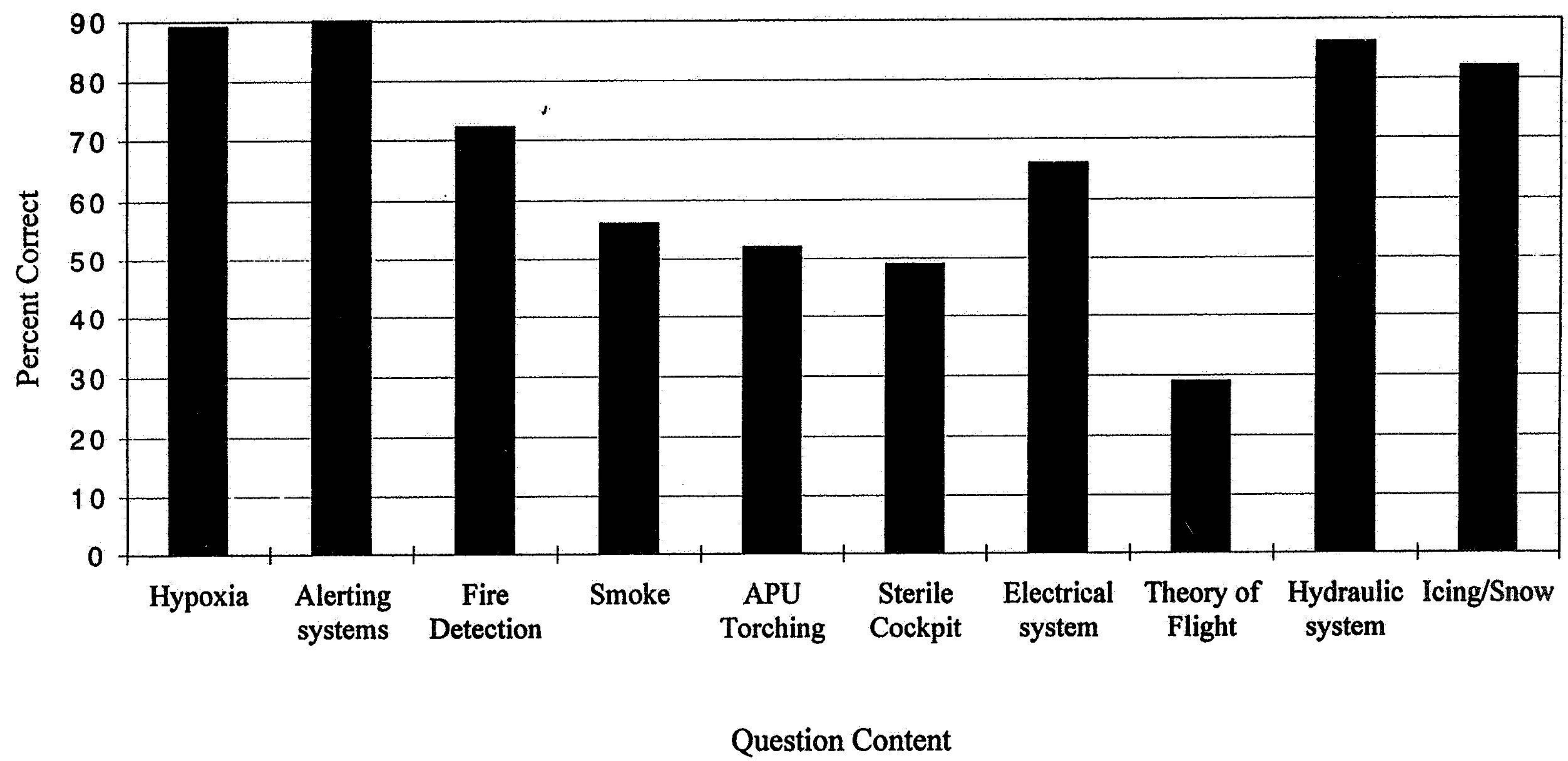
Figure 1. Frequency of flight attendant's correct answers on multiple choice items.

Figure 2. Frequency of correct answers on diagram of aircraft components.

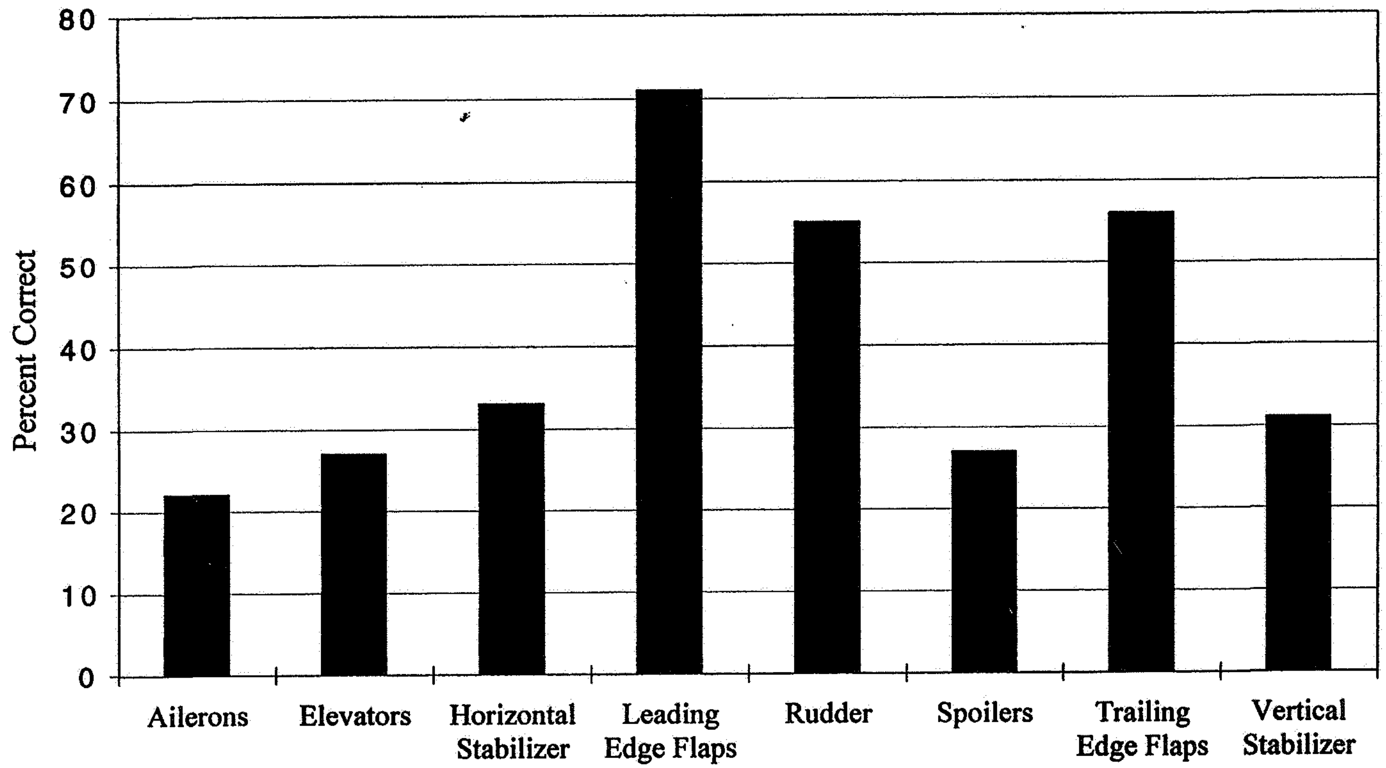
Figure 3. Average frequency of correct answers for subject areas where flight attendants with previous piloting experience scored significantly better than flight attendants without piloting experience.

Figure 4. Average ratings of flight attendant and pilot expectations of technical knowledge. Note: A rating of five is defined as the expectation that a flight attendant would be very knowledgeable in the given area, and a rating of one, as the expectation that a flight attendant would be not at all knowledgeable in that specific area.

Figure 5. Five most frequently given subject areas that flight attendants and pilots believe should be included in flight attendant training.



Percent Correct
90
80
70
60
50
40
30
20
10
0
Hypoxia
Alerting systems
Fire Detection
Smoke
APU Torching
Sterile Cockpit
Electrical system
Theory of Flight
Hydraulic system
Icing/Snow
Question Content


Percent Correct
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Elevators
Horizontal Stabilizer
Leading Edge Flaps
Rudder
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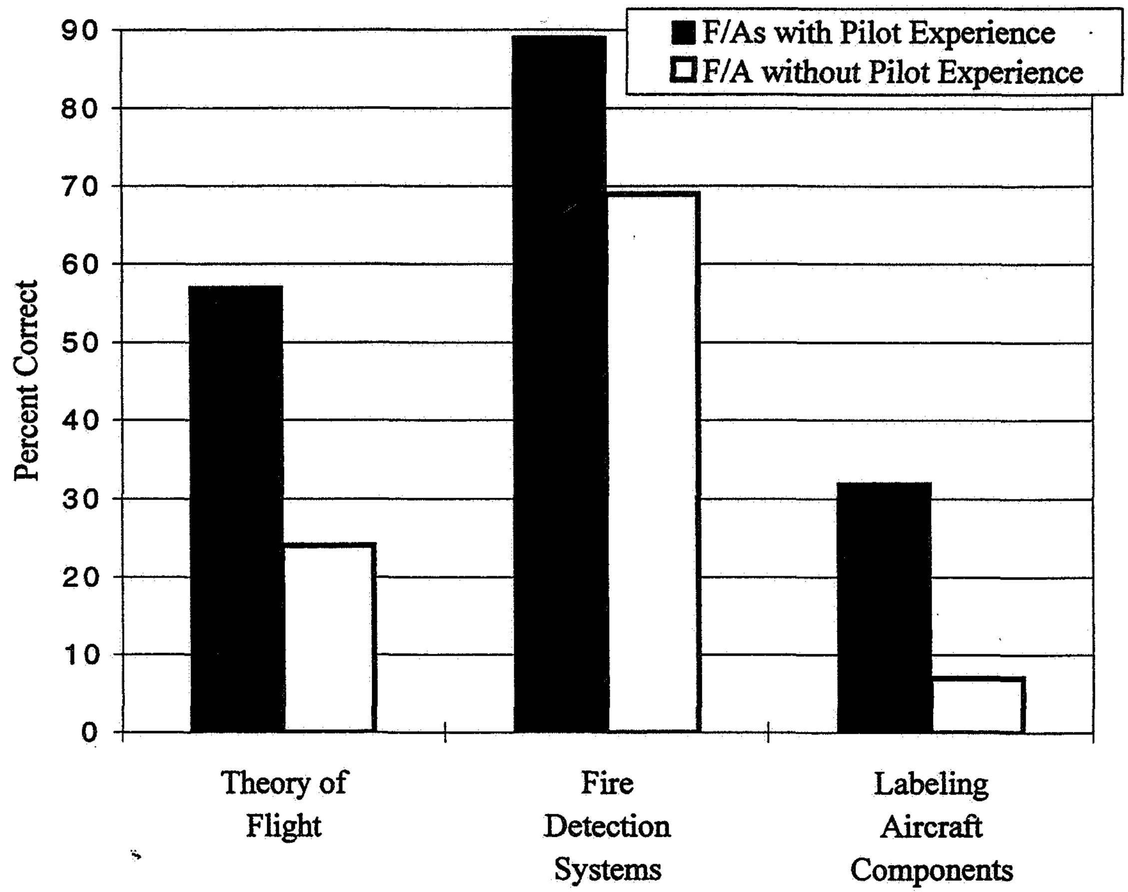
Trailing Edge Flaps
Vertical Stabilizer


F/As with Pilot Experience
F/A without Pilot Experience
Percent Correct
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70
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50
40
30
20
10
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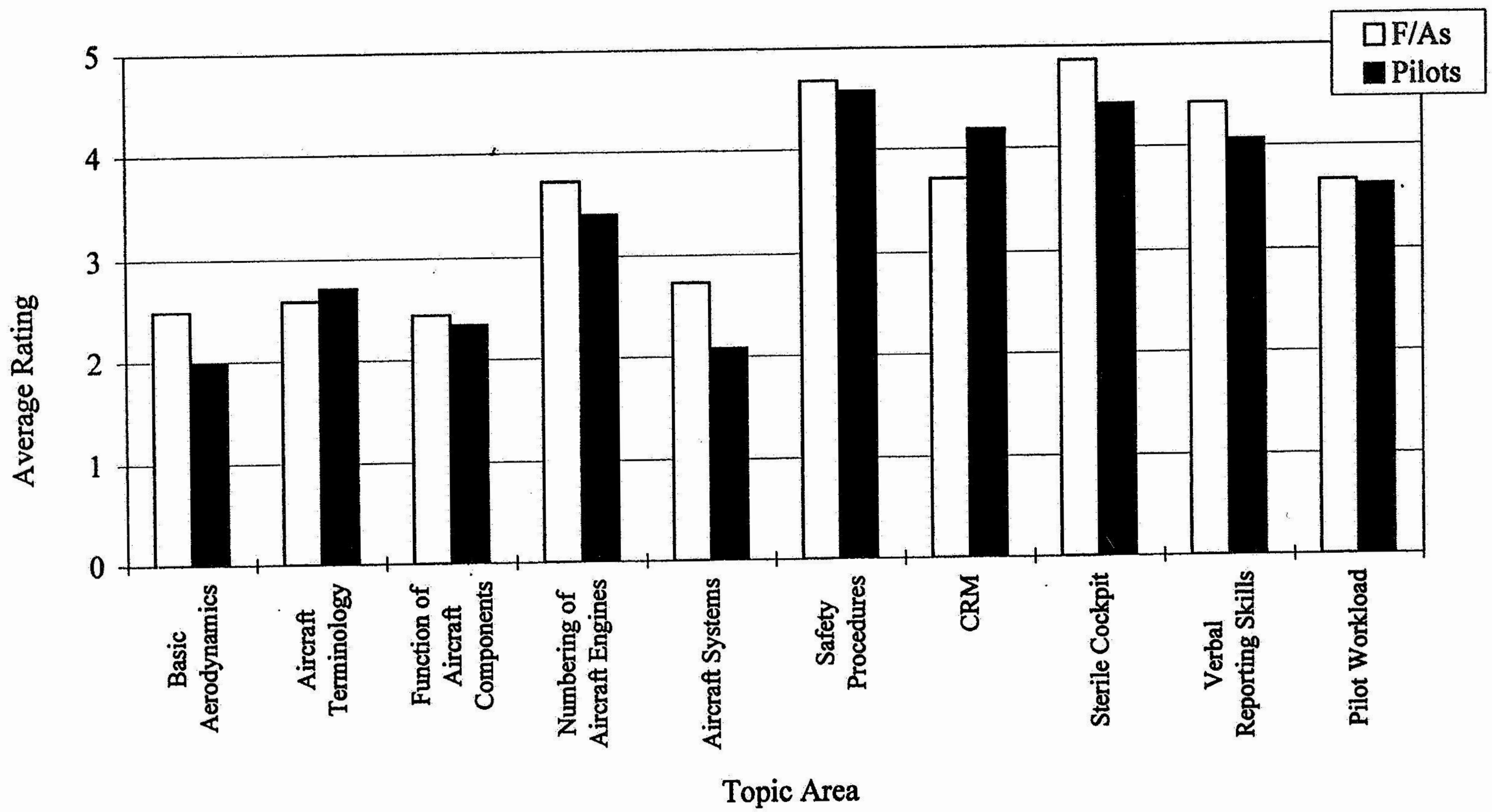
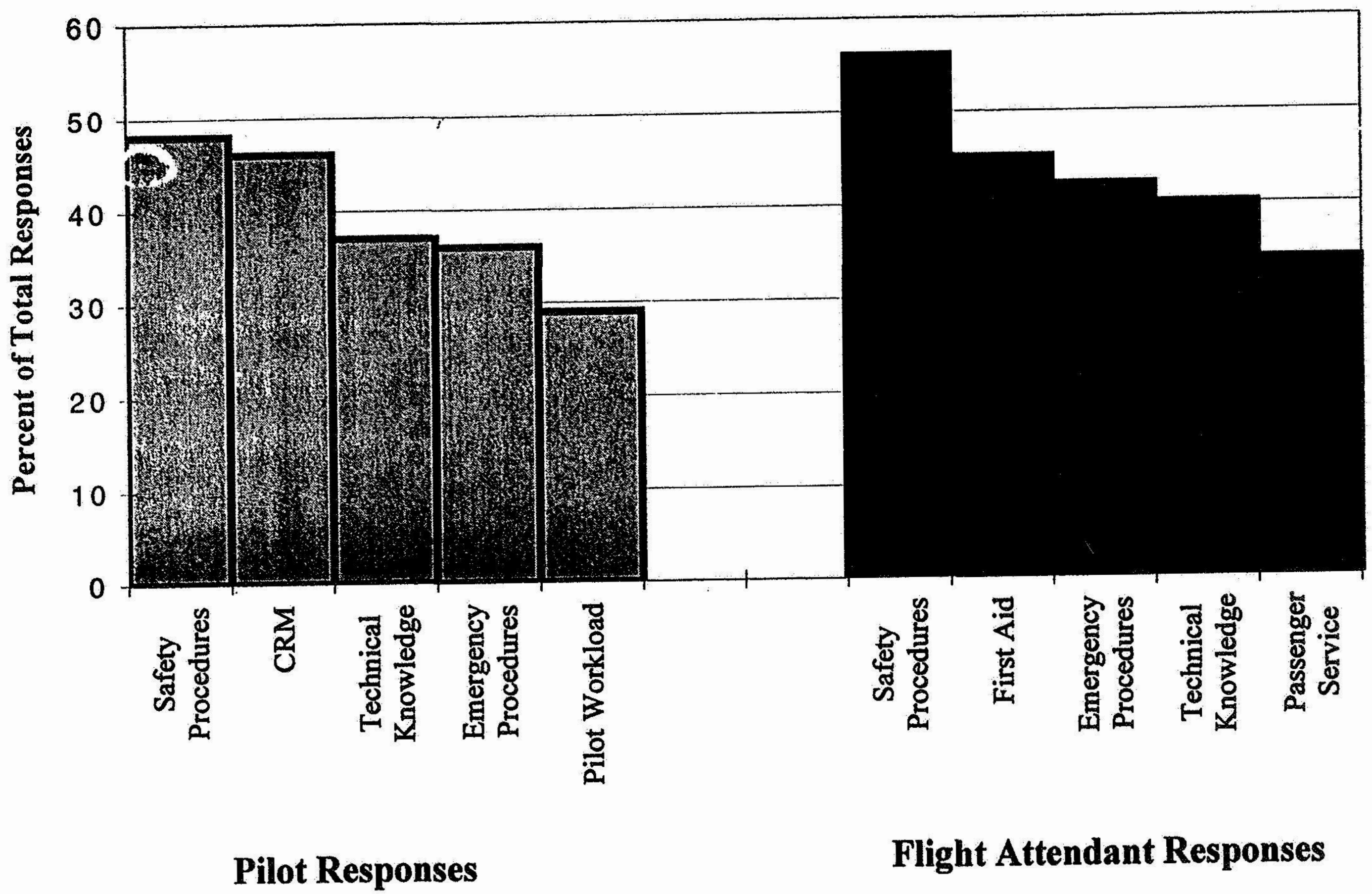
Theory of Flight
Fire Detection Systems
Labeling Aircraft Components


F/As
Pilots
Average Rating
5
4
3
2
1
0
Basic Aerodynamics
Aircraft Terminology
Function of Aircraft Components
Numbering of Aircraft Engines
Aircraft Systems
Safety Procedures
CRM
Sterile Cockpit
Verbal Reporting Skills
Pilot Workload
Topic Area


Percent of Total Responses
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50
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30
20
10
0
Safety Procedures
CRM
Technical Knowledge
Emergency Procedures
Pilot Workload
Safety Procedures
First Aid
Emergency Procedures
Technical Knowledge
Passenger Service
Pilot Responses
Flight Attendant Responses